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CHARLES J. BRAND, Chief

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A PRELIMINARY STUDY OF THE BLEACHING OF OATS WITH SULPHUR DIOXID.[1]

2774

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INTRODUCTION.

BLEACHING OATS with sulphur dioxid is a practice that has caused a great deal of controversy and discussion during the past few years. During the past score of years the commercial bleaching of oats and barley has greatly increased until, at the present time, this process is carried on to a considerable extent in nearly all of our larger oat-producing sections, the fundamental object being to improve the appearance of the product which is to be placed upon the market, and it was with a view to ascertaining the merits of this practice that these investigations were undertaken.

The character of the seasons in which oats are grown, and particularly the weather conditions prevailing at harvest time, have an influence upon their quality, condition, and appearance and determine quite largely the manner in which they are subsequently handled. Oats grown and harvested in a dry season are usually sufficiently bright and bleaching is not necessary to give them a good salable appearance. It is only upon oats which are harvested in a wet season that sulphur bleaching is practiced to any considerable extent, although a certain percentage of the lower grades of oats of all crops have been bleached during the past several years.

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[1] Other publications pertaining to this subject are:

Circular 40, Bureau of Plant Industry, U. S. Department of Agriculture: "A Simple Method of Detecting Sulphured Barley and Oats," by W. P. Carroll.

Circular 74, Bureau of Plant Industry, U. S. Department of Agriculture: "The Sulphur Bleaching of Commercial Oats and Barley," by LeRoy M. Smith.

Reprint from Circular 111, Bureau of Plant Industry, U. S. Department of Agriculture; "Improved Apparatus for Detecting Sulphured Grain," by George H. Baston.

Food Inspection Decision 145, Bureau of Chemistry, U. S. Department of Agriculture: "Bleached Oats and Barley".

Service and Regulatory Announcements 15, Bureau of Chemistry, U. S. Department of Agriculture: "Oats Bleached with Sulphur."

Service and Regulatory Announcements 16, Bureau of Chemistry, U. S. Department of Agricultur: "Oats Bleached with SO_2 and Oats Containing Added Barley."

These investigations were begun in 1915, and it is deemed advisable to present at this time the data in reference to the methods most commonly used, the results obtained by these methods, and the effects of bleaching on the grain itself. Many phases of the problem have not been investigated as yet, or sufficient data has not been obtained to justify their publication at this time. The attitude of the Department of Agriculture regarding the sulphur bleaching of oats is given in Service and Regulatory Announcements Nos. 15 and 16 of the Bureau of Chemistry.

METHOD OF BLEACHING OATS COMMERCIALLY.

The method of bleaching oats and barley commercially is practically the same throughout the country, with the occasional exception of a few changes in the technique that have been made by the individual operator, either better to adapt the process to his peculiar needs, or to give him what he considers a product of better quality. Two methods generally are in use, and these methods are practiced interchangeably by individual operators. These two processes are known as the cold process and the warm process, the only difference being that in one case steam is used to moisten the grain, and in the other cold water is used. The apparatus consists of a tower which is constructed of wood or concrete, an oven for burning the sulphur, a cooling chamber, a suction fan for drawing the fumes from the cooling chamber to the tower, where they are brought in contact with the oats, and a jet for injecting steam or water as the oats enter the tower. Fumes resulting from burning sulphur are drawn up through the moist grain while at the same time the grain runs from the top of the tower to the bottom, bringing as nearly as possible every kernel in contact with the sulphur fumes. Fumes of burning sulphur are sulphur dioxid (SO_2), which when combined with water form sulphurous acid (H_2SO_3), SO_2 plus $H_2O = H_2SO_3$, an active bleaching agent. It can readily be seen that the addition of water in some form is necessary for the formation of sulphurous acid and an ultimate bleaching of the product. After the oats have passed through the bleaching tower, they are usually run into a bin and allowed to stand over night, when they are cooled or dried as necessity may require. In the event that any considerable amount of water has been added during the process, it is usually necessary to dry out this excess moisture before the grain can be shipped with safety. Some operators prefer to add as little moisture as possible, in which case the product merely requires cooling before shipment. Others maintain that they get a better-appearing product by adding considerable moisture, and then drying out the excess before shipment.

The bleaching of oats and barley as practiced at the present time is a continuous process after the apparatus has once been set in motion, and very little attention is required except to see that the proper supply of sulphur is kept in the furnace, the proper amount of water is added, and that the grain is kept at a uniform flow. Some of the largest and most efficient bleaching plants have capacities of 2,000 bushels of grain per hour. Photographs of sulphur-bleaching apparatus are shown in figures 1, 2, and 3, which illustrate some of the leading types of commercial bleachers.

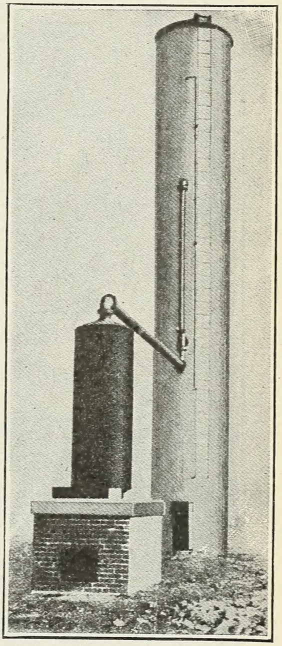

FIG. 1.—A modern grain bleacher.

CHARACTER OF INVESTIGATIONS.

In the fall of 1915, samples of oats were collected from representative sections in which the commercial bleaching of oats is practiced to a considerable extent, and these samples were carefully examined and analyzed. The analyses of samples from the same lots of grain before and after bleaching were compared. Using these data as a basis for further investigations, additional experiments were undertaken. Visits were made to some of the most important elevators throughout the Middle West that operate bleachers. Samples of as many different grades and qualities of oats as possible were obtained and studied. These were bleached by the regular process in vogue at the elevator, and also by modifications of this method which suggested themselves to the writer or were suggested by the operator of the elevator. Careful attention was paid to the amount of water absorbed, the atmospheric conditions, and the condition and appearance of the oats before and after bleaching. An endeavor was made at all times to improve if possible the appearance of the final product.

Each different grade or quality was carefully studied before and after treatment, and as many types of damaged oats as possible were obtained and examined. The effect of bleaching on each kind of damaged grain, such as weather stained, heat damaged, bin burned, and ground damaged, was carefully noted. This same line of experimentation was carried on at several representative points in order to get the benefit of varying conditions. Acknowledgment of appreciation is made for the assistance and cooperation given by the owners and operators of the elevators where experiments were conducted.

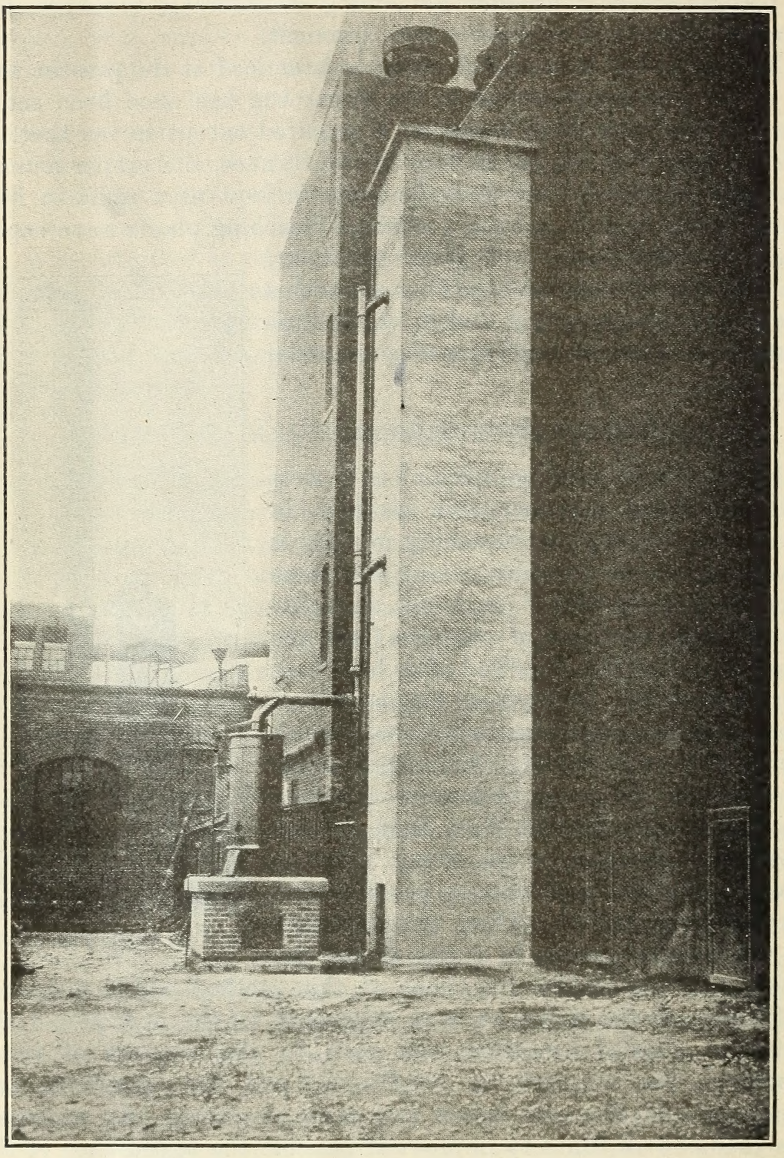

FIG. 2.—A grain bleaching apparatus with square tower. This type is in very common use throughout the Middle West.

In studying the comparisons between the natural and the sulphur-bleached grain, careful consideration was given to many sides of the problem. The comparisons, however, in this publication are those of laboratory tests—chemical, mechanical, and physical. The comparison of the value of the grain as a food product before and after bleaching is a separate problem, the study of which has but recently been undertaken by the Department of Agriculture.

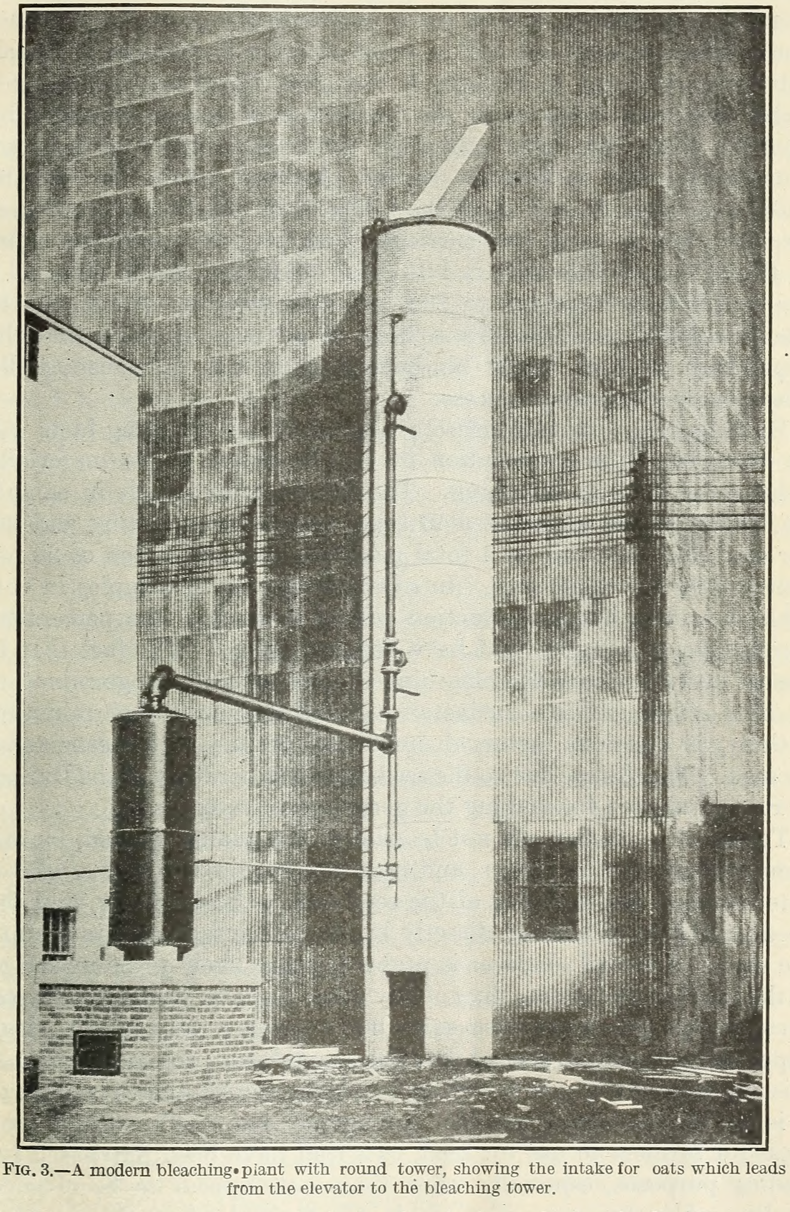

FIG. 3.—A modern bleaching plant with round tower, showing the intake for oats which leads from the elevator to the bleaching tower.

On examination of the table shown, in detail, in the appendix, it is found that almost the same conclusions hold true for the entire table. The percentage of germination, which is a very important factor from the standpoint of the planter, is in almost every case reduced by bleaching, and in some instances the power of germination is killed entirely. It will be noted that the percentage of kernels appearing damaged to the eye is less after bleaching. There is a larger difference, however, in the percentage of kernels damaged by agencies other than heat, although the heat-damaged kernels are considerably less in number in the bleached grain. As will be noticed in pages 10 and 11 of the table, badly bin-burned oats were bleached, and in these two particular lots the oats appearing sound to the eye were increased in lots Nos. 89242 and 89245 from 14.4 per cent before bleaching to 26.6 per cent after bleaching, and in lots Nos. 88672 and 88679 from 28 to 56 per cent, showing that the appearance of even badly bin-burned grain can be substantially raised by the bleaching process.

By examining the table closely, several very interesting facts will be observed. The germination of oats is shown to be materially reduced by sulphur bleaching. The largest reduction is in sample No. 88087, which germinated 97.5 per cent before treating and 9.5 per cent after treating, or a total reduction in germination of 88 per cent caused by sulphuring. In nearly every set of samples in this table, however, a large reduction will be noticed in the percentage germination of samples that have been sulphured. The fact that in almost every instance the bleaching of oats reduced the germination to some extent, and in some instances killed the power of germination entirely, is a serious factor whenever the grain is to be considered for seed. Thanks are due to the seed-testing laboratory of the Bureau of Plant Industry for making the germination tests.

Too much attention can not be paid to the quality of seed, for the same amount of time, labor, and money is required to sow a field of oats, whether the viability of the seed oats be high or low, and the product will be influenced directly by the percentage germination of the seed. A casual observer is probably more likely to be misled as to the true quality of oats than of any other grain for seeding purposes, because oats that have been sulphured present a very bright, clean appearance; therefore special care must be taken to ascertain whether this appearance is due to bleaching by sulphur or whether it is natural. It is not an uncommon practice throughout the smaller oat-growing areas for farmers to use for seed, oats that have been purchased for feeding purposes, especially when these oats appear to be of good quality. Usually very poor yields are secured when this is done because these oats may have been sulphur bleached and the consumer not be aware of the fact. Seed men generally buy their oats under contracts stipulating that such oats shall germinate not less than a specific percentage, and further that they shall not be sulphur bleached. This provision, of course, safeguards the farmer when he buys oats from a seedsman who states that such oats are suitable for seed. However, as at present there is no general regulation governing oat handling in intrastate transactions which requires that sulphured oats are to be labeled as such, the farmer generally is without protection and often sows oats that have been sulphured because he has no knowledge of such condition. Some growers are not acquainted with the sulphur-bleaching process, and do not know that this process injures the germination.

In the column headed ''Sulphur reaction'' are shown the results of a qualitative determination, indicating whether the oats in question had been sulphured or not.[1] In the column above referred to four designations are shown, namely: None, Slight, Medium, and Heavy, which indicate whether or not the oats have been sulphured, and if so, approximately to what degree. The moisture percentages will be found to vary considerably in the samples before and after sulphuring, according to the particular kind of method used. The weight per bushel, while not influenced materially, is found to be a little higher in most instances after sulphuring.

In the column headed ''Oats appearing sound,'' it will be noticed that the percentage of such oats is increased considerably by bleaching, and in the column headed ''Total oats appearing damaged,'' it is noticed that there is a corresponding decrease. In the column headed ''Oats damaged by agencies other than heat,'' it is shown that in the sulphured samples the damage appears much less. In the last column, headed ''Heat damaged oats,'' it is seen that while the percentage of heat damage in many instances is small, there is a corresponding reduction in this factor by the bleaching process.

By examining the table in detail, it is noted that the facts set forth in each set compare favorably with those in each of the other sets. In samples Nos. 88783 and 88830 it is shown that the total amount of oats appearing heat damaged was reduced from 54.8 to 31.4 per cent, a reduction of 23.4 per cent. In samples Nos. 89242 and 89245, however, it is seen that the total amount of oats appearing bin burned before sulphuring was 62 per cent while those appearing bin burned after sulphuring was 64.6 per cent.

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[1] This method is given in detail in Circular 40, Bureau of Plant Industry, U. S. Department of Agriculture: "A Simple Method of Detecting Sulphured Barley and Oats," by W. P. Carroll, 1909; and in Circular 111, Bureau of Plant Industry, U. S. Department of Agriculture: "Improved Apparatus for Use in Detecting Sulphured Grain," by George H. Baston, 1913

SUMMARY.

1. The sulphur bleaching of oats has been practiced during the past score of years, but the practice has increased during the last few years.

2. Investigations show that it is possible to bleach weather-stained, discolored, and damaged oats, giving them the appearance of natural oats of good quality.

3. It is possible to improve slightly the appearance of badly bin-burned and ground-damaged oats, thereby concealing a part of the damage.

4. The viability of oats is materially reduced by sulphur bleaching.

5. The methods used for bleaching are practically uniform throughout the oat-bleaching sections, with an occasional modification to meet the needs of individual operators.

6. The character of the season in which oats are harvested, whether a wet or dry season, has a direct influence upon the subsequent handling of the crop. Oats harvested in a dry season are rarely bleached, because they show little if any damage.

APPENDIX.

TABLE I.—*A comparison of oats before and after bleaching.*

[The figures shown in the table represent the analysis of samples as received, and the determination of other grain, seed, dirt, and foreign material has been omitted from the table.]

	Laboratory No.	Sulphur reaction.	Germination.	Moisture.	Weight per bushel.	Oats appearing sound.	Total oats appearing damaged.	Oats appearing damaged by agencies other than heat.	Oats appearing heat damaged.
			P. ct.	*P. ct.*	*Lbs.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Before sulphuring	87897	None	56.0	12.9	30.25	50.4	45.2	39.2	6.0
After sulphuring	87898	Medium	.5	14.7	31.9	66.3	28.8	24.8	4.0
Before sulphuring	87899	None	64.0	15.2	32.5	25.2	71.6	71.6	......
After sulphuring (5 hours' standing).	87901	Medium	......	15.7	33.1	37.6	56.4	56.4	......
After sulphuring, after cooling	87900	do	.5	15.6	32.25	42.8	52.8	52.8	......
Before sulphuring	87935	None	64.0	14.0	33.7	49.2	48.8	47.6	1.2
After sulphuring (24 hours' standing).	87937	Medium	3.0	15.5	34.8	63.2	32.4	31.2	1.2
After sulphuring, after cooling	87936	do	10.0	15.5	34.0	70.6	23.6	22.8	.8
Before sulphuring	88074	None	91.0	14.8	35.0	76.2	19.7	19.0	.7
After sulphuring, before cooling	88075	Slight	38.0	16.0	36.0	84.2	12.0	11.6	.4
After sulphuring, after cooling	88076	Medium	45.2	15.7	34.9	86.0	11.0	11.0	Trace.
After sulphuring, cooling, and clipping.	88077	do	49.0	15.3	36.5	84.4	11.6	11.0	.6
Before sulphuring, before clipping.	88087	None	97.5	14.2	36.3	88.2	8.9	8.9	......
Before sulphuring, after clipping	88088	do	94.5	14.4	39.25	88.1	8.9	8.9	......
After sulphuring, after clipping	88089	Medium	17.5	15.2	39.6	94.1	2.0	2.0	......
After sulphuring, cooling, and clipping.	88090	do	9.5	14.4	39.75	94.0	2.7	2.7	......
Before sulphuring	88322	None	93.6	14.2	39.25	83.0	12.0	12.0	......
After sulphuring, before cooling	88323	Medium	26.0	14.6	40.4	87.4	6.8	6.8	......
After sulphuring, after cooling	88324	do	33.0	14.9	40.4	84.2	9.6	9.6	......
Before sulphuring	88338	None	91.5	13.8	38.0	77.8	19.6	19.2	.4
After sulphuring, before cooling	88339	Slight	1.5	14.3	38.6	88.2	9.3	9.3	......
After sulphuring, after cooling	88340	do	5.5	13.8	38.25	87.2	9.5	9.5	Trace.
Before sulphuring	88460	None	95.5	14.6	37.2	89.0	7.6	7.6	......
After sulphuring, before cooling	88461	Heavy	39.0	14.9	37.7	93.1	2.6	2.6	......
After sulphuring, after cooling	88462	do	29.5	15.1	37.7	92.5	4.2	4.2	Trace.
Before sulphuring	88528	None	95.0	14.4	38.7	73.8	22.9	22.9	......
After sulphuring, before cooling	88529	Slight.	82.0	15.4	40.9	92.6	5.2	5.2	......
After sulphuring, after cooling	88530	do	77.0	14.8	40.5	87.9	9.8	9.8	......
Before sulphuring	88531	None	94.5	14.5	39.9	83.8	13.6	13.6	......
After sulphuring, before cooling	88532	Medium	73.0	15.3	38.7	92.0	5.4	5.2	.2
After sulphuring, after cooling	88533	Slight	78.0	15.2	39.0	89.2	8.5	8.2	.3
Before sulphuring	88534	None	94.0	14.6	39.0	82.6	14.6	14.2	.4
After sulphuring, before cooling	88535	Medium	.5	16.0	39.0	93.6	4.4	4.4	......
After sulphuring, after cooling	88536	do	44.0	15.2	39.3	90.8	7.2	7.2	......
Before sulphuring	87796	None	53.0	......	......	53.2	43.2	36.8	6.4
After sulphuring (from sulphur tower).	87798	Heavy	......	......	......	66.9	29.2	23.8	5.4
After sulphuring (24 hours' standing).	87797	Medium.	.5	......	34.0	67.9	29.2	16.4	12.8
Before sulphuring (dried and clipped).	87799	None	46.0	......	38.0	45.3	52.7	28.5	24.2
After sulphuring (from sulphur tower).	87801	Medium.	13.0	......	38.0	48.6	48.5	23.4	25.2
After sulphuring (24 hours' standing).	87800	Heavy	13.0	......	37.5	60.2	38.2	20.2	18.0
Before sulphuring (dried and clipped).	87802	None	41.0	......	37.5	46.4	51.2	29.6	21.6
After sulphuring (from sulphur tower).	87804	Medium	21.0	......	35.5	56.8	40.8	17.2	23.6
After sulphuring (24 hours' standing).	87803	Slight	24.0	......	36.0	71.2	27.6	12.8	14.8

TABLE I.—*A comparison of oats before and after bleaching*—Continued.

	Laboratory No.	Sulphur reaction.	Germination.	Moisture.	Weight per bushel.	Oats appearing sound.	Total oats appearing damaged.	Oats appearing damaged by agencies other than heat.	Oats appearing heat damaged.
			P. ct.	*P. ct.*	*Lbs.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Before sulphuring (clipped)	87843	None	44.0	-------	39.0	46.4	51.6	26.4	25.2
After sulphuring (from sulphur tower).	87844	Slight	-------	-------	38.0	46.6	51.8	29.2	21.6
After sulphuring (24 hours' standing).	87845	do	9.0	-------	38.25	45.8	52.2	27.8	24.4
Before sulphuring	87869	None	1.0	15.7	33.5	12.2	85.8	7.6	77.2
After sulphuring (from sulphur tower).	87870	Heavy	-------	17.2	34.5	18.5	80.5	8.6	71.9
After sulphuring (24 hours' standing).	87871	do	-------	16.5	33.5	26.0	72.4	8.4	64.0
Before sulphuring	87892	None	61.0	12.2	32.9	60.8	36.5	24.6	11.9
After sulphuring (from sulphur tower).	87893	Heavy	-------	21.3	32.75	73.6	24.8	18.4	6.4
After sulphuring (24 hours' standing).	87894	do	7.0	15.4	36.0	77.5	21.7	15.1	6.6
Before sulphuring	87902	None	50.0	13.3	38.5	49.3	49.6	19.2	30.4
After sulphuring (from sulphur tower).	87903	Medium	22.0	17.8	36.5	61.3	36.7	17.5	19.2
After sulphuring (24 hours' standing).	87904	do	14.0	17.1	36.5	55.2	43.6	18.8	24.8
Before sulphuring	87939	None	80.0	-------	-------	49.6	48.8	48.8	-------
After sulphuring	87940	Medium	.5	-------	-------	70.8	28.0	25.2	2.8
After sulphuring and clipping	87941	do	58.0	-------	-------	68.6	29.8	29.0	.8
Before sulphuring	87942	None	14.0	-------	-------	20.0	75.4	22.3	53.1
After sulphuring	87943	Heavy	.5	-------	-------	60.3	37.0	21.2	15.8
After sulphuring and clipping	87944	do	.5	-------	-------	58.5	39.9	18.5	20.4
Before sulphuring	87945	None	88.0	-------	-------	59.2	39.4	38.8	.6
After sulphuring	87946	Medium	3.0	-------	-------	74.2	24.2	19.6	4.6
After sulphuring and clipping	87947	None	80.0	-------	-------	65.0	33.2	28.4	4.8
Graded No. 3 White oats.									
Before sulphuring	88605	do	89.0	14.3	36.0	79.6	16.0	11.2	4.8
After sulphuring (from sulphur tower).	88639	Medium	84.0	15.7	36.5	92.6	5.2	5.2	Trace.
After sulphuring (1 hour's standing).	88606	do	76.0	15.4	37.0	92.4	4.8	4.8	Trace.
After sulphuring, before cooling	88607	do	56.5	15.0	36.0	90.8	6.0	5.2	.8
After sulphuring, after cooling	88608	do	89.0	14.6	40.75	84.4	12.4	10.0	2.4
After sulphuring and clipping	88609	do	67.0	14.8	41.0	83.2	13.6	12.0	1.6
Graded No. 3 White oats.									
Before sulphuring	88610	None	63.0	15.2	37.0	88.8	8.8	7.2	1.6
After sulphuring (from sulphur tower).	88611	Medium	9.0	15.7	39.8	92.8	6.0	5.6	.4
After sulphuring, before cooling	88640	do	53.5	15.7	40.5	90.6	7.8	7.0	.8
After sulphuring, after cooling	88612	do	66.0	15.3	39.5	88.0	8.8	8.0	.8
Bin-burned oats.									
Before sulphuring	88672	None	21.0	14.0	35.5	28.0	69.2	18.4	50.4
After sulphuring (from sulphur tower).	88673	Medium	-------	14.7	35.5	44.4	51.6	12.8	38.8
After sulphuring, before cooling	88696	do	-------	15.0	35.8	54.0	43.2	10.8	32.4
After sulphuring, after cooling	88697	do	-------	14.5	35.6	56.0	41.2	8.8	32.4
Graded No. 3 White oats.									
Before sulphuring	88670	None	79.5	14.2	32.0	62.4	35.6	33.6	2.0
After sulphuring (from sulphur tower).	88671	Medium	22.5	15.1	32.0	26.0	21.6	20.4	1.6
After sulphuring, before cooling	88698	do	26.0	15.3	31.8	79.6	17.6	16.4	1.2
After sulphuring, after cooling	88699	do	44.5	15.4	32.25	80.2	17.4	14.0	3.4

TABLE I.—*A comparison of oats before and after bleaching*—Continued.

	Laboratory No.	Sulphur reaction.	Germination.	Moisture.	Weight per bushel.	Oats appearing sound.	Total oats appearing damaged.	Oats appearing damaged by agencies other than heat.	Oats appearing heat damaged.
Graded No. 4 White oats.			*P. ct.*	*P. ct.*	*Lbs.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Before sulphuring	88781	None	61.0	12.3	33.25	76.0	22.8	21.6	1.2
After sulphuring (from sulphur tower).	88782	Slight	17.5	17.1	33.25	82.4	15.6	14.8	.8
Graded No. 4 White oats, clipped.									
Before sulphuring	88757	None	67.5	13.6	35.0	79.2	19.6	16.8	2.8
After sulphuring (from sulphur tower).	88758	Heavy	9.5	16.6	38.0	94.8	4.0	4.0	-------
After sulphuring (24 hours' standing).	88773	Slight	45.5	16.0	37.6	89.6	8.8	8.0	.8
After sulphuring (24 hours' standing—steam).	88774	do	27.5	16.5	37.5	89.8	9.4	7.6	1.8
Bin-burned oats.									
Before sulphuring	88783	None	10.5	12.1	33.25	28.0	69.6	14.8	54.8
Before sulphuring, clipped	88784	do	14.5	12.2	36.0	26.0	71.2	13.2	58.0
After sulphuring, clipped (from sulphur tower).	88785	Medium	1.5	18.2	33.0	45.0	52.0	13.6	38.4
After sulphuring, clipped (from sulphur tower—steam).	88786	Heavy	-------	25.5	30.25	39.8	55.6	12.8	32.8
After sulphuring, clipped (24 hours' standing).	88830	do	9.0	16.7	35.7	53.0	45.0	13.6	31.4
Clipped White oats.									
Before sulphuring	88846	None	82.0	14.5	40.4	92.4	6.4	4.4	Trace.
After sulphuring (from sulphur tower).	88847	Heavy	-------	18.6	36.7	92.4	6.4	5.6	.8
After sulphuring (24 hours' standing).	88848	do	14.5	18.3	37.3	89.2	9.6	8.0	1.6
Graded No. 3 White oats.									
Before sulphuring	88726	None	70.5	14.2	--------	87.6	11.6	10.0	1.6
After sulphuring (from sulphur tower).	88727	Medium	-------	14.8	--------	72.0	23.6	13.2	10.0
After sulphuring (loading into car)	88728	do	33.0	16.0	--------	71.6	25.2	14.4	10.8
Graded No. 3 White oats.									
Before sulphuring	89231	None	90.5	12.4	33.0	82.0	12.8	12.4	.4
After sulphuring (from sulphur tower).	89232	Slight	84.5	12.8	34.0	93.0	3.6	3.2	.4
After sulphuring, before cooling	89240	do	82.5	13.0	35.3	89.2	4.4	4.4	-------
After sulphuring, after cooling	89241	do	77.0	12.7	34.7	86.8	6.0	6.0	-------
Bin-burned oats.									
Before sulphuring	89242	None	5.5	12.7	34.6	14.4	82.8	20.8	62.0
After sulphuring (from sulphur tower).	89243	Slight	-------	13.1	34.6	34.6	62.4	8.4	54.0
After sulphuring, before cooling	89244	do	-------	13.1	36.5	37.6	61.2	17.2	44.0
After sulphuring, after cooling	89245	do	1.5	13.1	35.6	26.6	70.2	5.6	64.6
Graded No. 3 White oats.									
Before sulphuring	89139	None	90.0	12.0	30.0	81.2	14.0	14.0	-------
After sulphuring (from sulphur tower).	89140	Slight	77.0	12.7	27.3	87.0	7.6	7.2	.4
After sulphuring (24 hours' standing).	89143	do	84.0	15.5	25.0	78.0	10.8	10.8	-------
Graded No. 3 White oats, clipped.									
Before sulphuring	89141	None	95.5	12.6	32.3	86.0	9.2	9.2	-------
After sulphuring (from sulphur tower).	89142	Slight	-------	17.8	27.3	88.0	9.2	9.2	-------
After sulphuring (24 hours' standing).	89144	do	42.0	19.1	28.7	88.8	7.2	7.2	-------

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